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**Storm**

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(54) **METHODS AND SYSTEMS FOR  
CONTROLLING AN ENERGY RECOVERY  
VENTILATOR (ERV)**

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U.S.C. 154(b) by 254 days.

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**F24F 11/00** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **F24F 12/006** (2013.01); **F24F 11/0079**  
(2013.01); **Y02B 30/563** (2013.01); **Y02B**  
**30/746** (2013.01)

(58) **Field of Classification Search**  
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F24F 11/0079; G05B 15/02; Y02B 30/563;  
Y02B 30/746  
USPC ..... 700/278, 277; 454/329; 159/4.1, 24.2  
See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

7,181,317 B2 2/2007 Amundson et al.  
8,374,725 B1\* 2/2013 Ols ..... 700/277

8,457,933 B2\* 6/2013 Yoo et al. .... 703/2  
2005/0178124 A1\* 8/2005 Kirby ..... F01K 21/00  
60/653  
2007/0045441 A1 3/2007 Ashworth et al.  
2008/0230206 A1\* 9/2008 Lestage et al. .... 165/48.1  
2008/0238607 A1\* 10/2008 Schuricht et al. .... 340/3.1  
2009/0204262 A1\* 8/2009 Nishimura ..... 700/276  
2009/0271154 A1\* 10/2009 Coad et al. .... 703/1  
2010/0070089 A1\* 3/2010 Harrod et al. .... 700/277  
2010/0070907 A1\* 3/2010 Harrod et al. .... 715/772  
2010/0076605 A1\* 3/2010 Harrod et al. .... 700/276  
2010/0256958 A1\* 10/2010 Yoo et al. .... 703/2  
2010/0320277 A1 12/2010 Stark  
2011/0146941 A1\* 6/2011 Benoit et al. .... 165/11.1

(Continued)

**FOREIGN PATENT DOCUMENTS**

CN 101893293 A 11/2010  
FR 2939872 A1 6/2010  
FR 2942300 A1 8/2010

(Continued)

**OTHER PUBLICATIONS**

TenWolde, "Ventilation, humidity, and condensation in manufac-  
tured houses during winter", 1994, ASHRAE Transactions, vol. 100,  
pp. 1-14.\*

(Continued)

*Primary Examiner* — Carlos Ortiz Rodriguez

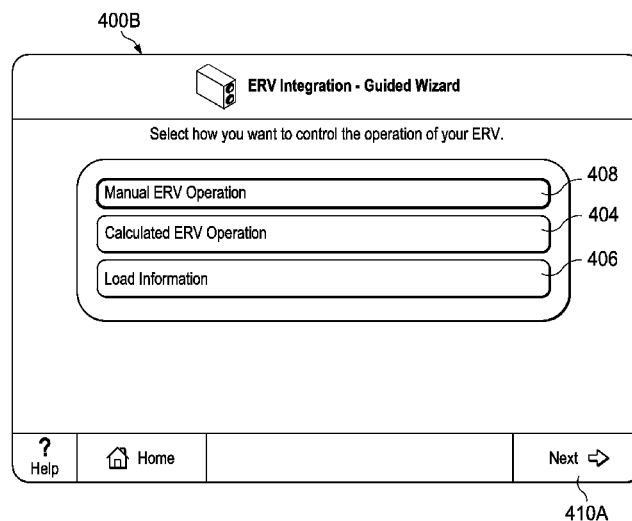
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Brown, Jr.; Michael J. Schofield

(57) **ABSTRACT**

In at least some embodiments, a system includes a heat pump  
and an energy recovery ventilator (ERV). The system also  
includes a controller coupled to the heat pump and the ERV.  
The controller implements an ERV operation algorithm that  
automates operations of the ERV.

**11 Claims, 7 Drawing Sheets**



(56)

**References Cited**

U.S. PATENT DOCUMENTS

2011/0151766 A1\* 6/2011 Sherman et al. .... 454/239  
2012/0052791 A1\* 3/2012 Kurelowech ..... 454/329

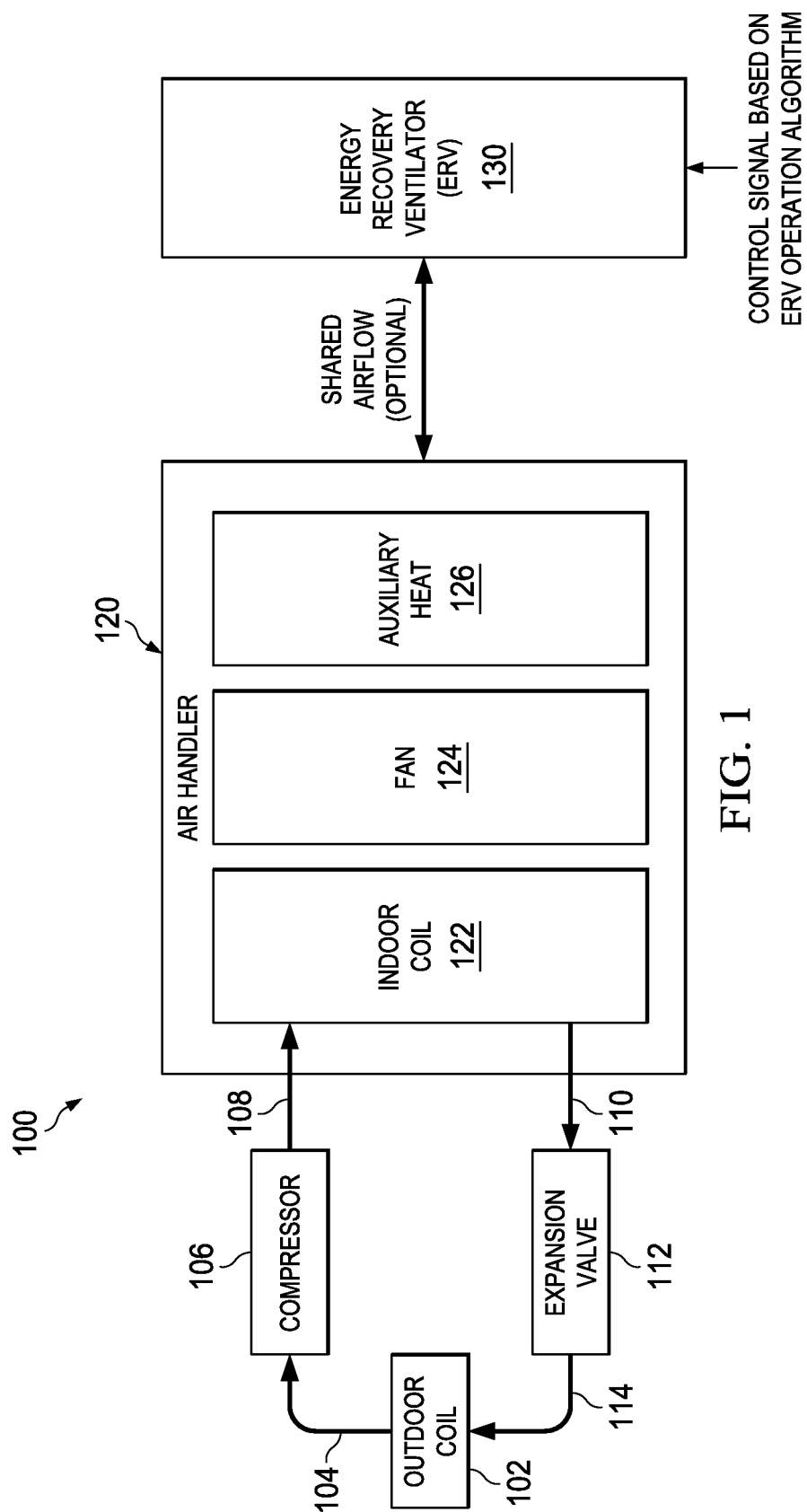
FOREIGN PATENT DOCUMENTS

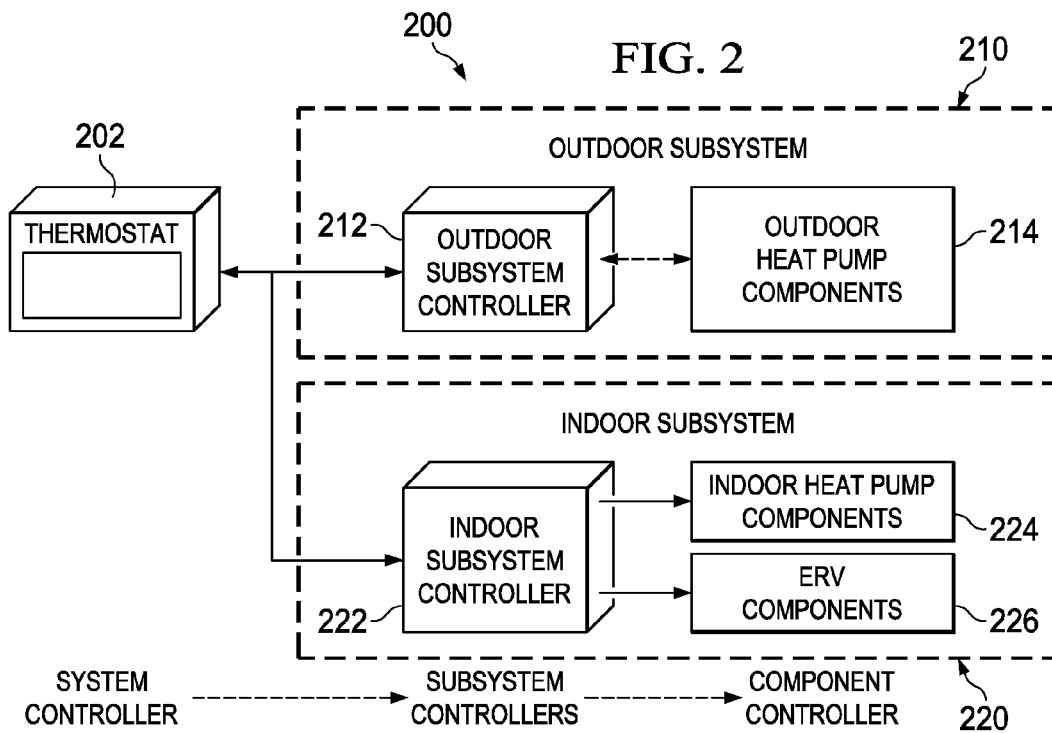
WO 9715793 A1 5/1997  
WO 2007095985 A1 8/2007  
WO 2008146843 A1 12/2008  
WO 2011004025 A1 7/2010  
WO 2011004025 A1 1/2011

OTHER PUBLICATIONS

PCT International Search Report; PCT Application No. PCT/US2012/026116; Aug. 23, 2012; 4 pgs.  
PCT Written Opinion of the International Searching Authority; PCT Application No. PCT/US2012/026116; Aug. 23, 2012; 6 pgs.  
Chinese Office Action; Application No. 201280016780.8; Jul. 2, 2015; 30 pages.  
Canadian Office Action; Application No. 2,829,277; Nov. 6, 2014; 3 pages.

\* cited by examiner





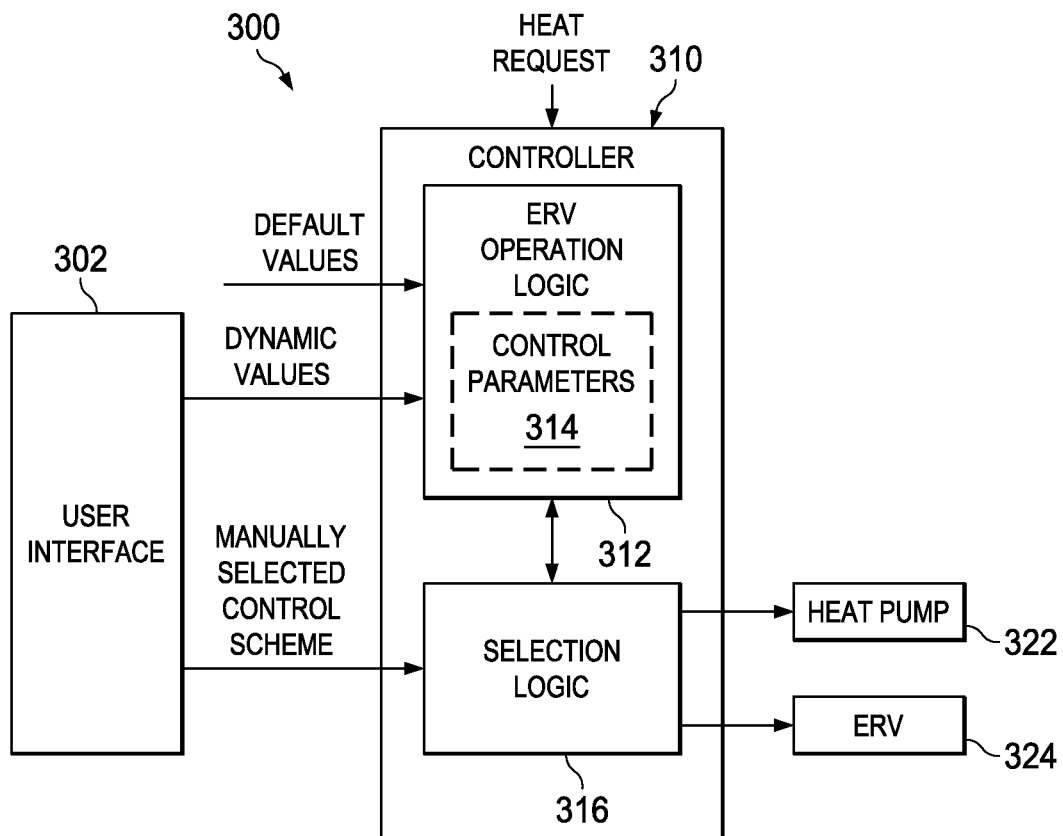


FIG. 3

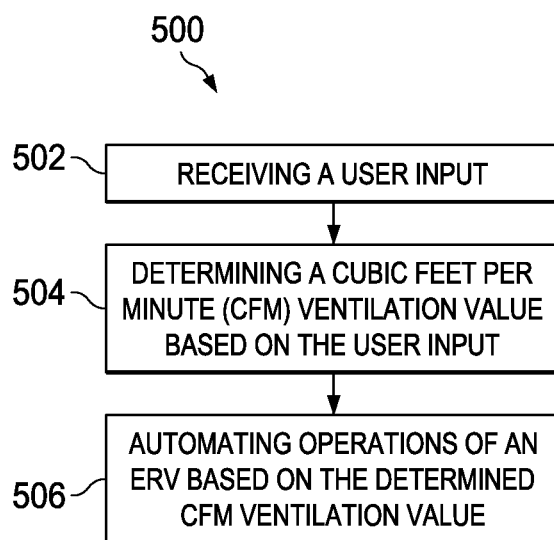


FIG. 5

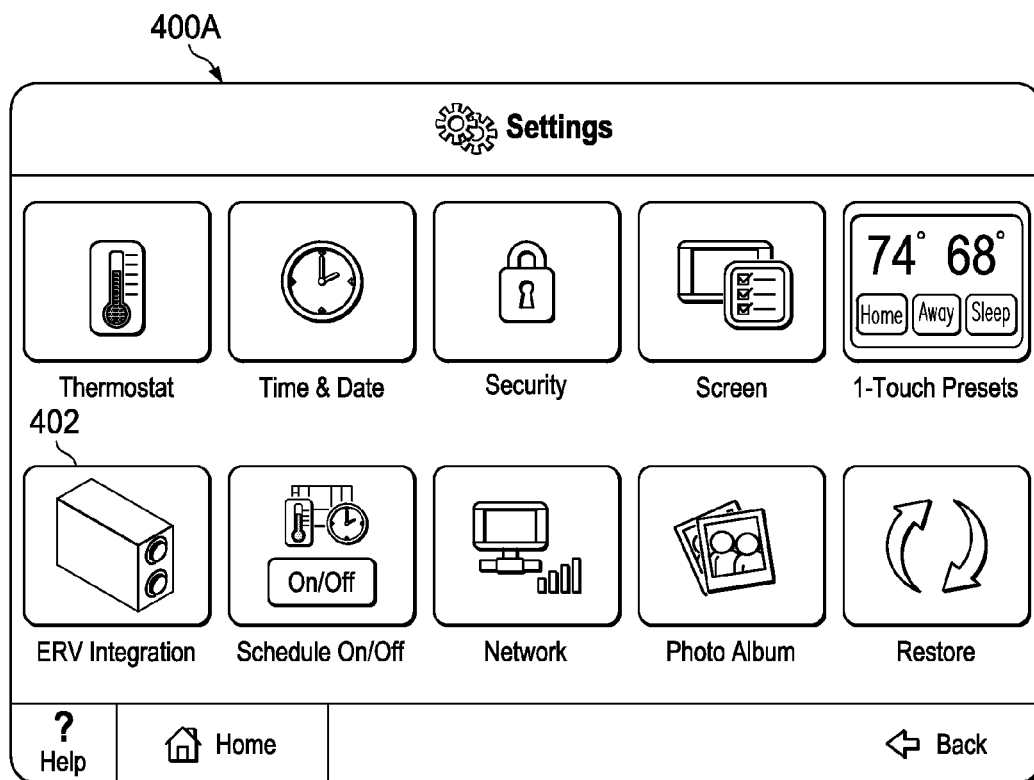


FIG. 4A

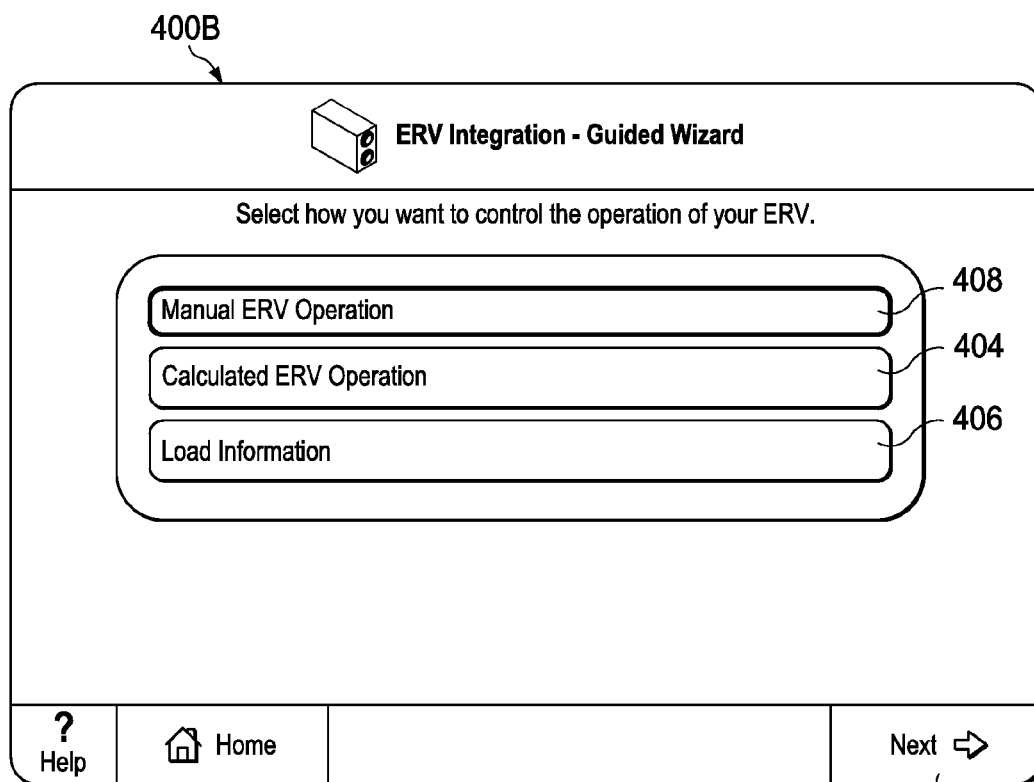



FIG. 4B

400C

 **ERV Integration - Guided Wizard**

Select the Indoor/Outdoor Conditions

412

	Indoor Design Conditions				Outdoor Design Conditions			
	Dry Bulb	Wet Bulb	Relative Humidity	Air Enthalpy	Dry Bulb	Wet Bulb	Relative Humidity	Air Enthalpy
Cooling	75		50	28.107	95		80	54.706
Heating	70		30	21.875	0		30	0.249

Enter either WB or RH but not both.




? Help   Home    Back   Next 

FIG. 4C   416A   410B

400D

 **ERV Integration - Guided Wizard**

Select Home Size

413

414

Home Information:						
	Sq Feet	3	Number of Bedrooms	Outdoor Air Minimum:		CFM
Code or Design CFM for Home:				(a)per ASHRAE 62.2		




? Help   Home    Back   Next 


FIG. 4D   416B   410C

400E

 **ERV Integration - Guided Wizard**

Select number of ERVs


420 **Number of Systems:** 1

? Help  Home Back Next

416C 410D

**FIG. 4E**

400F

 **ERV Integration - Guided Wizard**

Select ERV Model

ERV Data for System 1 Serves: 422




Model:  ▼

Design CFM Desired:

SUPPLY SIDE DATA			EXHAUST SIDE DATA		
Static:	0.1	"w.g.	Static:	0.1	"w.g.
100% "ON" CFM:			100% "ON" CFM:		

Supply Air Temperature				Enthalpy Effectiveness	
	Summer Dry Bulb		Winter Dry Bulb		Summer
	Summer Wet Bulb		Winter Wet Bulb		Winter

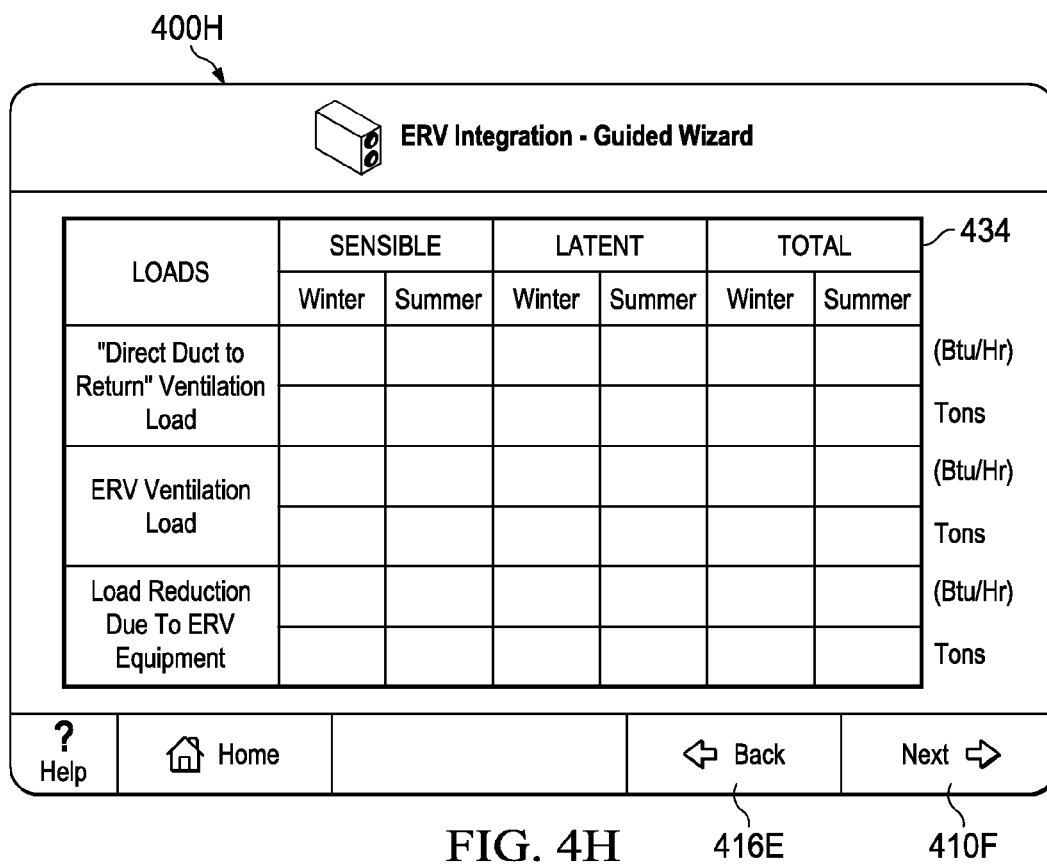
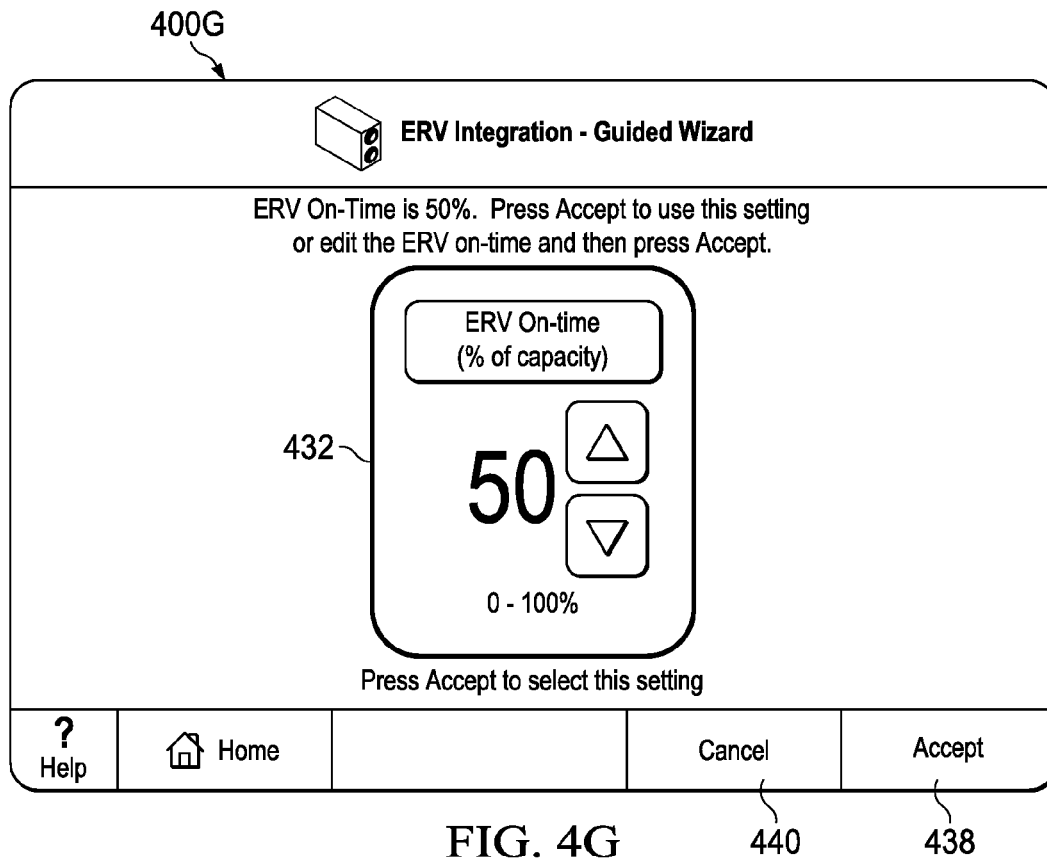
Unit 1 Recommended Minimum PT Control Setting:  
At this setting CFM will be delivered to this location in the home

? Help  Home  Back Next 

416D 410E

**FIG. 4F**





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# METHODS AND SYSTEMS FOR CONTROLLING AN ENERGY RECOVERY VENTILATOR (ERV)

## CROSS-REFERENCE TO RELATED APPLICATIONS

Not applicable.

## STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

## REFERENCE TO A MICROFICHE APPENDIX

Not applicable.

## BACKGROUND

In a heat pump and refrigeration cycle, refrigerant alternately absorbs and rejects thermal energy as it circulates through the system and is compressed, condensed, expanded, and evaporated. In particular, a liquid refrigerant flows from a condenser, through an expansion device (e.g., expansion valve) and into an evaporator. As the refrigerant flows through the expansion device and evaporator, the pressure of the refrigerant decreases, the refrigerant phase changes into a gas, and the refrigerant absorbs thermal energy. From the evaporator, the gaseous refrigerant proceeds to a compressor, and then back to the condenser. As the refrigerant flows through the compressor and condenser, the pressure of the refrigerant is increased, the refrigerant phase changes back into a liquid, and the refrigerant gives up thermal energy. The process is implemented to emit thermal energy into a space (e.g., to heat a house) or to remove thermal energy from a space (e.g., to air condition a house).

A heat recovery ventilator (HRV) can help make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows. HRVs use heat exchangers to heat or cool incoming fresh air, recapturing up to 80 percent of the conditioned temperatures that would otherwise be lost. Models that exchange moisture between the two air streams are referred to as Energy Recovery Ventilators (ERVs). ERVs are especially recommended in climates where cooling loads place strong demands on heating, ventilation, and air conditioning (HVAC) systems. In operation, ERVs transfer moisture from the humid air stream (incoming outdoor air in the summer) to the exhaust air stream. Efficient use of ERVs is not a trivial task and differs according to the installation environment.

## SUMMARY OF THE DISCLOSURE

In at least some embodiments, a system includes a heat pump and an energy recovery ventilator (ERV). The system also includes a controller coupled to the heat pump and the ERV. The controller implements an ERV operation algorithm that automates operations of the ERV.

In at least some embodiments, a control system for an ERV includes a user interface and ERV operation logic coupled to the user interface. The ERV operation logic is configured to automate operations of an ERV based on user inputs via the user interface.

In at least some embodiments, a method for controlling an ERV includes receiving, by a controller, a user input. The ERV also includes determining, by the controller, a cubic feet

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per minute (CFM) ventilation value based on the user input. The method also includes automating, by the controller, operations of the ERV based on the determined CFM ventilation value.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an HVAC system with an energy recovery ventilator (ERV) in accordance with an embodiment of the disclosure;

FIG. 2 illustrates a control system for the HVAC system of FIG. 1 in accordance with an embodiment of the disclosure;

FIG. 3 illustrates a block diagram of a system in accordance with an embodiment of the disclosure;

FIGS. 4A-4H shows windows of a user interface program for controlling ERV operations in accordance with an embodiment of the disclosure; and

FIG. 5 shows a method in accordance with an embodiment of the disclosure.

## DETAILED DESCRIPTION

The disclosed embodiments describe systems and methods to facilitate integration of an energy recovery ventilator (ERV) with a heating, ventilation, and air conditioning (HVAC) system. In at least some embodiments, an ERV operation algorithm is implemented to control when an ERV operates (turns on/off). The ERV operation algorithm accounts for the environment (e.g., indoor space) associated with the ERV to ensure efficient operation of the ERV. For example, the ERV operation algorithm may determine an appropriate cubic feet per minute (CFM) ventilation value for the environment of the ERV and automates operating the ERV based on the determined CFM ventilation value. The determined CFM ventilation value may be based on default values regarding the ERV environment and/or information provided by a user via a user interface. In at least some embodiments, the control system for ERV operations enables a user to override/ignore the ERV operation algorithm and thereby customize when the ERV operates.

FIG. 1 illustrates an HVAC system 100 with an energy recovery ventilator (ERV) 130 in accordance with an embodiment of the disclosure. In the HVAC system 100, refrigerant cycles through outdoor coil 102, compressor 106, indoor coil 122 and expansion valve 112. The arrows 104, 108, 110 and 114 show the direction of flow for refrigerant in a heating cycle. For a cooling cycle, the direction of flow for refrigerant in HVAC system 100 would be reversed.

In a heating cycle, the outdoor coil 102 causes refrigerant to evaporate. As the liquid refrigerant evaporates it pulls heat from the outside air. The gaseous refrigerant flows (arrow 104) from the outdoor coil 102 to compressor 106, where the gaseous refrigerant is compressed to produce a high-pressure, superheated refrigerant vapor. The vapor leaves compressor 106 and flows (arrow 108) to the indoor coil 122. At the indoor coil 122, air from fan (blower) 124 removes heat from the vapor (warming the indoor air) and, when enough heat is removed, the vapor condenses into a high-pressure liquid. This high-pressure liquid flows (arrow 110) from the indoor coil 122 to the expansion valve 112, which meters the flow (arrow 114) of the high-pressure liquid to the outdoor coil 102. The heating cycle process described herein can be repeated as needed. For example, the heating cycle of HVAC system 100 may be activated and/or maintained in response to a thermostat control signal.

As shown in FIG. 1, the indoor coil 122 and the fan 124 may be components of an air handler 120. The air handler 120

may also comprise an auxiliary furnace **126**, which is activated as needed. Alternatively, the auxiliary furnace **126** may be separate from the air handler **120**. In either case, the HVAC system **100** comprises the ERV **130**, which is controlled in accordance with an ERV operation algorithm as described herein. The ERV operation algorithm determines when to operate the ERV **130**. In some embodiments, the ERV operation algorithm accounts for ERV configurations where ERV operations should be synchronized with heat pump or auxiliary furnace operations. Such synchronization is needed, for example, when the airflow (ducting) for ERV operations is at least partly shared with the airflow for heat pump operations or auxiliary furnace operations. Although the ERV operations described herein may be synchronized with a heat pump as described herein, it should be understood that other ERV operations are possible. For example, an ERV may operate as a stand-alone device, or may operate with a heat pump (heating or cooling), a furnace, or other HVAC system components.

FIG. 2 illustrates a control system configuration **200** for the HVAC system **100** of FIG. 1 in accordance with an embodiment of the disclosure. The control system configuration **200** illustrates a hierarchical control for HVAC systems, including those with an ERV as disclosed herein. As shown, the thermostat **202** operates as the overall system controller of configuration **200** and is configured to communicate with an indoor subsystem controller **222** of indoor subsystem **220** and an outdoor subsystem controller **212** of outdoor subsystem **210**. The indoor subsystem **220** may comprise, for example, indoor heat pump components **224** (e.g., air handler **120**) and ERV components **226** (e.g., ERV **130** of FIG. 1). Meanwhile, the outdoor subsystem **210** comprises outdoor heat pump components **214** such as the compressor **106** and the outdoor coil **102** described for FIG. 1. In at least some embodiments, the indoor subsystem controller **222** implements some or all of the ERV operation algorithm features described herein.

FIG. 3 illustrates a block diagram of a system **300** in accordance with an embodiment of the disclosure. As shown, the system **300** comprises a controller **310** coupled to a heat pump **322** and an ERV **324**. In at least some embodiments, the controller **310** and the user interface **302** corresponds to the indoor subsystem controller **222** of FIG. 2. In various embodiments, the user interface **302** corresponds to an interface on a thermostat or other control unit that enables user interaction to control operations of the heat pump **322** and the ERV **324**. Alternatively, the user interface **302** may correspond to a computer program or web portal accessible via a handheld computing device (e.g., a smart phone), a laptop and/or a desktop computer.

In FIG. 3, the controller **310** comprises ERV operation logic **312** configured to select when to operate the ERV **324**. The ERV operation logic **312** also may ensure that the ERV **324** operates at the same time as the heat pump **322** for configurations where the heat pump **322** and the ERV **324** share air ducts. To summarize, the ERV operation logic **312** comprises hardware (e.g., an ASIC, a microcontroller, a processor and/or a memory), or a combination of hardware and software, to perform the ERV operation algorithm described herein.

In accordance with at least some embodiments, the ERV operation logic **312** employs control parameters **314** to determine when to operate the ERV **324**. Values for the control parameters **314** may be based on previously stored default values and/or based on dynamic values received via the user interface **302**. As an example, the control parameters **314** may correspond to a square footage parameter of the indoor space environment associated with the ERV **324**. The square foot-

age parameter (or other parameters) may be received via the user interface, which provides appropriate query forms to a user.

In at least some embodiments, a CFM ventilation value is determined based on a default square footage parameter value or a square footage parameter value received from a user. Alternatively, a user may manually provide a CFM ventilation value via the user interface **302**. In either case, the CFM ventilation value may then be compared with a total CFM capacity of the ERV **324**. The ERV **324** may be operated based on the comparison. As a specific example, if the CFM ventilation value is 30% of the total CFM capacity of the ERV **324**, the ERV operation logic **312** operates the ERV **324** at 30% of its total capacity. Assuming there is only one operational speed for ERV **324**, operating the ERV at 30% of its total capacity refers to activating the ERV **324** for 30% of the total time possible. In some embodiments, the ERV **324** may simply receive a command from a user to operate at a percentage of its total capacity without determining the CFM ventilation value.

The control parameters **314** also may enable the ERV operation logic **312** to determine a load for automated operations of the ERV **324**. In such embodiments, the control parameters **314** comprise a relative humidity parameter that is used to determine the load. The relative humidity parameter may be received via the user interface **302**. The determined load information may be presented to the user (e.g., via user interface **302**) and may include sensible load information and latent load information related to automated operations (determined by the ERV operation algorithm) of the ERV **324**.

In FIG. 3, the selection logic **316** coupled to the ERV operation logic **312** may receive a recommendation or control signal from the ERV operation logic **312**. In response to a control signal from the ERV operation logic **312**, the selection logic **316** asserts a control signal to activate the ERV **324** and, if appropriate (e.g., when the heat pump **322** and the ERV **324** share airflow/duct paths), the heat pump **322**. In accordance with at least some embodiments, the heat pump **322** and the ERV **324** are independently activated, but may be operated together.

The selection logic **316** is also configured to receive a manually selected control scheme for the ERV **324** from the user interface **302**. The manually selected control scheme may correspond to adjusting or overriding a previously calculated percentage of the total capacity of the ERV **324**. In other words, the user interface **302** enables a user to selectively disable and enable control of ERV operations based on the ERV operation logic **312**. Additionally or alternatively, the user interface **302** enables a user to manually set a percentage of the total capacity at which the ERV **324** operates (or to otherwise control the amount of time that the ERV operates).

FIGS. 4A-4H show windows of a user interface program for controlling ERV operations in accordance with an embodiment of the disclosure. For example, the user interface program may be part of the user interface **302** described for FIG. 3. In FIG. 4A, window **400A** shows a "settings" menu including an ERV integration icon **402** that can be selected by clicking on it. Selection of the ERV integration icon **402** enables a user to adjust control features for an ERV (e.g., the ERV **324** of FIG. 3). The other icons of FIG. 4A correspond to other control features or utilities accessible via the user interface program.

In FIG. 4B, window **400B** shows an ERV integration menu that appears in response to clicking the ERV integration icon **402** of window **400A**. The ERV integration menu of window **400B** enables a user to manually adjust control features and/

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or control parameter values for an ERV. For example, clicking on the “manual ERV operation” box **408** and then clicking the “next” button **410A** enables a user to manually set when the ERV operates.

In FIG. 4G, a window **400G** with an ERV “on-time” utility **432** is shown. The window **400G** may be displayed, for example, after clicking on the manual ERV operation box **408** and the “next” box **410A** in window **400B**. The ERV on-time utility **432** enables a user to manually select an ERV on-time value for the ERV **324**. The ERV on-time value displayed by the ERV on-time utility **432** may be initially set to a default value (e.g., 50%) and may be adjusted within a predetermined range (e.g., 0-100%). After selecting an ERV on-time value using the ERV on-time utility **432**, a user is able to apply the selected ERV on-time value by clicking the “accept” button **438**. In window **400G**, selection of the “cancel” button **440** cancels any adjustments to the existing ERV on-time value and causes window **400B** of FIG. 4B to be displayed again. Although only one ERV on-time utility **432** is shown in window **400G**, it should be understood that when multiple ERVs are used, window **400G** may show a separate ERV on-time utility **432** for each ERV.

Returning to window **400B**, clicking on the “calculated ERV operation” box **404** and then clicking on the “next” button **410A** enables a user to input values for control parameters (e.g., control parameters **314** of FIG. 3) of an ERV operation algorithm. In other words, selection of the calculated ERV operation box **404** causes implementation of the ERV operation algorithm for controlling the ERV **324**. The various control parameter values for the ERV operation algorithm are input by a user via the user interface program as shown in windows **400D-400F** of FIGS. 4D-4F. Although not shown, one or more default values may be provided in the user interface program for the control parameters used with the ERV operation algorithm. In addition to entering control parameters for the ERV operation algorithm in windows **400D-400F**, a user also may enter relative humidity information in window **400C** of FIG. 4C to determine load information for a manually selected ERV on-time setting or a calculated ERV on-time setting.

In FIG. 4C, window **400C** includes an air enthalpy utility **412** that determines an air enthalpy value based on a dry bulb value and a relative humidity or, alternatively, based on a wet bulb value. More specifically, an air enthalpy value can be determined for various conditions including an indoor cooling condition, an indoor heating condition, an outdoor cooling condition, and an outdoor heating condition. For the indoor cooling condition, an indoor dry bulb value of 75 and an indoor relative humidity value of 50 results in an air enthalpy value of 28.107. For the indoor heating condition, an indoor dry bulb value of 70 and an indoor relative humidity value of 30 results in an air enthalpy value of 21.875. For the outdoor cooling condition, an outdoor dry bulb value of 95 and a relative humidity value of 80 results in an air enthalpy value of 54.706. For the outdoor heating condition, an outdoor dry bulb value of 0 and a relative humidity value of 30 results in an air enthalpy value of 0.249. Again, a wet bulb value could be used instead of dry bulb values and relative humidity values. In either case, the air enthalpy values determined by air enthalpy utility **412** can be utilized to determine load information for a manually selected ERV on-time setting or a calculated ERV on-time setting. To accept the air enthalpy values determined by air enthalpy utility **412**, a user selects the “next” button **410B** to return to window **400B**. Alternatively, the user may return to window **400B** without entering relative humidity value into the air enthalpy utility

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**412** (or without accepting air enthalpy values determined by air enthalpy utility **412**) by clicking on the “back” button **416A**.

Once a manually selected ERV on-time setting has been accepted or a calculated ERV on-time setting has been accepted, the air enthalpy values determined by air enthalpy utility **412** enable load information table **434** of window **400H** (see FIG. 4H) to be populated with sensible load values for a “direct duct to return” ventilation load, for an ERV ventilation load, and for a load reduction due to ERV equipment. The load information table **434** is also populated with latent load values for the “direct duct to return” ventilation load, for the ERV ventilation load, and for load reduction due to ERV equipment. The load information table **434** is also populated with total load values (sensible load plus latent load) for the “direct duct to return” ventilation load, for the ERV ventilation load, and for load reduction due to ERV equipment. In at least some embodiments, the populated table **434** of window **400H** can be viewed by clicking on the “load information” button **406** in window **400B** and then clicking on the “next” button **410A**.

In the load information table **434** of window **400H**, the “direct duct to return” ventilation load refers to a ventilation load where no ERV is used. Thus, the values for the load reduction due to ERV equipment refer to the difference between the load values when no ERV ventilation is used (“direct duct to return” ventilation is used) and the load values for the ERV ventilation load. In window **400H**, clicking on the “back” button **416E** may cause window **400C** of FIG. 4C to be displayed, where the air enthalpy utility **412** may be accessed to update/adjust the air enthalpy values used to populate the load information table **434**. Alternatively, clicking on the “next” button **410F** of window **400H** may cause window **400B** to be displayed.

Returning to FIGS. 4D-4F, various windows **400D-400F** enable selection of control parameter values for an ERV operation algorithm. The windows **400D-400F** may be displayed in series, for example, after clicking on the calculated ERV operation box **404** and the “next” box **410A**. In FIG. 4D, the window **400D** includes a CFM utility **413** that determines a CFM ventilation value based on an indoor square footage value entered by a user in space **414**. In at least some embodiments, the determined CFM ventilation value may be based on correlating the entered indoor square footage with predetermined CFM ventilation values in ASHRAE 62.2 or another source. To accept the determined CFM ventilation value, a user selects the “next” button **410C** to proceed to window **400E**. Alternatively, a user can return to window **400B** by selecting the “back” button **416B**.

In FIG. 4E, window **400E** includes a “number of ERVs” selector **420** that enables a user to select how many ERVs are being used. To accept the selected number of ERVs indicated by selector **420**, a user clicks the “next” button **410D**. Alternatively, a user can return to window **400D** by clicking the “back” button **416C**.

For each ERV selected using selector **420**, window **400F** of FIG. 4F displays an ERV model selector **422** that enables a user to select one of a plurality of ERV models. The selection of an ERV model using ERV model selector **422** populates the various data fields of window **400F** with corresponding CFM capacity information and/or enthalpy effectiveness information. In at least some embodiments, clicking on the “back” button **416D** in window **400F** causes window **400E** of FIG. 4E to be displayed. Meanwhile, clicking on the “next” button **410E** in window **400F** causes another window **400F** to be displayed if additional numbers of ERVs were selected by selector **420**. If there are no more ERVs to select, clicking on

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the “next” button **410E** causes window **400G** to be displayed, where an ERV on-time utility **432** is displayed for each ERV. The ERV on-time value shown for each ERV on-time utility **432** would be set in accordance with the control parameter values entered in windows **400D-400F**. Each ERV on-time utility **432** also enables a user to adjust the determined ERV on-time value up or down. With or without adjustment, a user is able to accept the ERV on-time value for each ERV on-time utility **432** by selecting the “accept” button **438**. In window **400G**, selection of the “cancel” button **440** cancels any adjustments to the existing ERV on-time value and causes window **400B** of FIG. 4B to be displayed again.

Although windows **400C-400H** describe various features and utilities in a particular order, the windows presented herein are not intended to limit other user interface embodiments that may implement ERV control features as described herein. In other words, user interface embodiments may vary with regard to how ERV control information is presented to a user and how a user enters ERV control parameters.

FIG. 5 shows a method **500** in accordance with an embodiment of the disclosure. The method **500** may be performed by a controller (e.g., controller **310**) or control system for an HVAC system with one or more ERVs as described herein. As shown, the method **500** comprises receiving a user input (block **502**). At block **504**, a CFM ventilation value is determined based on the user input. Finally, the method **500** comprises automating operations of an ERV based on the determined CFM ventilation value (block **506**). For example, automating operations of the ERV based on the determined CFM ventilation value may involve comparing the determined CFM ventilation value with a total CFM capacity of the ERV and automating operations of the ERV based on the comparison.

In at least some embodiments, the method **500** may additionally comprise selectively synchronizing automated operations of the ERV with operations of a heat pump. For example, this may be done if the ERV and heat pump share at least some air ducts. Additionally, the method **500** may comprise estimating load information for automated operations of the ERV based on relative humidity information received from a user.

At least one embodiment is disclosed and variations, combinations, and/or modifications of the embodiment(s) and/or features of the embodiment(s) made by a person having ordinary skill in the art are within the scope of the disclosure. Alternative embodiments that result from combining, integrating, and/or omitting features of the embodiment(s) are also within the scope of the disclosure. Where numerical ranges or limitations are expressly stated, such express ranges or limitations should be understood to include iterative ranges or limitations of like magnitude falling within the expressly stated ranges or limitations (e.g., from about 1 to about 10 includes, 2, 3, 4, etc.; greater than 0.10 includes 0.11, 0.12, 0.13, etc.). For example, whenever a numerical range with a lower limit,  $R_L$ , and an upper limit,  $R_u$ , is disclosed, any number falling within the range is specifically disclosed. In particular, the following numbers within the range are specifically disclosed:  $R = R_L + k \cdot (R_u - R_L)$ , wherein  $k$  is a variable ranging from 1 percent to 100 percent with a 1 percent increment, i.e.,  $k$  is 1 percent, 2 percent, 3 percent, 4 percent, 5 percent, . . . 50 percent, 51 percent, 52 percent, . . . 95 percent, 96 percent, 97 percent, 98 percent, 99 percent, or 100 percent. Moreover, any numerical range defined by two  $R$  numbers as defined in the above is also specifically disclosed. Use of the term “optionally” with respect to any element of a claim means that the element is required, or alternatively, the element is not required, both alternatives being within the scope of the claim. Use of broader terms such as comprises,

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includes, and having should be understood to provide support for narrower terms such as consisting of, consisting essentially of, and comprised substantially of. Accordingly, the scope of protection is not limited by the description set out above but is defined by the claims that follow, that scope including all equivalents of the subject matter of the claims. Each and every claim is incorporated as further disclosure into the specification and the claims are embodiment(s) of the present invention.

What is claimed is:

1. A system, comprising:

a heat pump;

an energy recovery ventilator (ERV); and

a controller coupled to the heat pump and the ERV, wherein the controller selectively implements an ERV operation algorithm that automates a ventilating operation of the ERV, wherein the ERV operation algorithm determines a cubic feet per minute (CFM) ventilation value based on a square footage value, compares the CFM ventilation value with a total CFM capacity of the ERV, and automates the ventilating operation of the ERV based on the comparison;

wherein the controller comprises a user interface that selectively provides an input prompt for selection between (1) operating the controller to control the ERV according to the ERV operation algorithm and (2) operating the controller to operate the ERV according to a user selectable percentage of a total capacity of the ERV without respect to the CFM ventilation value;

wherein the user interface comprises an air enthalpy utility that determines an air enthalpy value as a result of selectively entering at least one of (1) a relative humidity value and a dry bulb temperature and (2) a wet bulb temperature; and

wherein the ERV operation algorithm utilizes the air enthalpy value to determine a direct duct to return ventilation load and an ERV ventilation load to operate the ERV for at least one of (1) a calculated ERV on-time setting and (2) a manually selected ERV on-time setting.

2. The system of claim 1 wherein the controller directs operations of the ERV and the heat pump independently.

3. The system of claim 1 wherein the controller directs the heat pump to operate at the same time as the ERV.

4. The system of claim 1 wherein the CFM ventilation value is determined based on input received via the user interface.

5. The system of claim 4 wherein the user interface provides a square footage query form and wherein the CFM ventilation value is determined based on square footage information received via the square footage query form.

6. The system of claim 1 wherein the user interface displays sensible load information and latent load information related to the automated ventilating operation of the ERV using the ERV operation algorithm.

7. A control system for an energy recovery ventilator (ERV), the control system comprising:

a user interface; and

ERV operation logic coupled to the user interface, wherein the ERV operation logic is configured to automate a ventilating operation of the ERV based on user inputs via the user interface;

wherein the ERV operation logic determines a cubic feet per minute (CFM) ventilation value based on user input via the user interface, compares the CFM ventilation value with a total CFM capacity of the ERV, and selectively automates the ventilating operation of the ERV based on the comparison;

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wherein the controller comprises a user interface that selectively provides an input prompt for selection between (1) controlling the ERV according to the ERV operation logic and (2) controlling the ERV according to a user selectable percentage of a total capacity of the ERV without respect to the CFM ventilation value;

wherein the user interface comprises an air enthalpy utility that determines an air enthalpy value as a result of selectively entering at least one of (1) a relative humidity value and a dry bulb temperature and (2) a wet bulb temperature; and

wherein the ERV operation logic utilizes the air enthalpy value to determine a direct duct to return ventilation load and an ERV ventilation load to operate the ERV for at least one of (1) a calculated ERV on-time setting and (2) a manually selected ERV on-time setting.

8. The control system of claim 7 wherein the ERV operation logic selectively synchronizes the ventilating operation of the ERV with operation of a heat pump.

9. The control system of claim 7 wherein the ERV operation logic automates the ventilating operation of the ERV based on square footage information received via the user interface.

10. A method for controlling an energy recovery ventilator (ERV), comprising:

receiving, by a controller, a user input;

determining, by the controller, a cubic feet per minute (CFM) ventilation value based on the user input;

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comparing the CFM ventilation value with a total CFM capacity of the ERV; and

selectively automating, by the controller, a ventilating operation of the ERV based on comparing the CFM ventilation value with the total CFM capacity of the ERV;

wherein the controller comprises a user interface that selectively provides an input prompt for selection between (1) operating the controller to control the ERV as a function of the determined CFM ventilation value and (2) operating the controller to control the ERV according to a user selectable percentage of a total capacity of the ERV without respect to the determined CFM ventilation value;

wherein the user interface comprises an air enthalpy utility that determines an air enthalpy value as a result of selectively entering at least one of (1) a relative humidity value and a dry bulb temperature and (2) a wet bulb temperature; and

wherein an ERV operation algorithm utilizes the air enthalpy value to determine a direct duct to return ventilation load and an ERV ventilation load to operate the ERV for at least one of (1) a calculated ERV on-time setting and (2) a manually selected ERV on-time setting.

11. The method of claim 10 further comprising selectively synchronizing the automated ventilating operation of the ERV with operation of a heat pump.

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